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environmental restoration project

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Environmental Cleanup Program

Environmental Restoration Project
Standard Operating Procedure

for:

Well Development

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NATIONAL LABORATORY
Los Alamos, New Mexico 87545

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Revision Log

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0	6/1/92	Sandra Wagner	New Procedure	All
1	06/01/99	J. Skalski & B. Gilkeson	NA	NA
2	4/27/01	William Stone, Steve Pearson, Joe Skalski	Update procedures; new SOP format	all

Well Development

Table of Contents

Well Development

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures for the development of monitor wells subsequent to drilling and installation at the Los Alamos National Laboratory (Laboratory) ER Project.

2.0 SCOPE

This SOP is a mandatory document and shall be implemented by all ER Project participants when performing well development procedures for the ER Project.

3.0 TRAINING

3.1 All users of this SOP are trained by reading the procedure, and the training is documented in accordance with the most recent version of QP-2.2.

3.2 The Field Team Leader (FTL) shall ensure the proper implementation of this procedure and that relevant team members have completed all applicable training assignments in accordance with the most recent version QP-2.2.

4.0 DEFINITIONS

Note: A glossary of definitions can be located on the ER Project internal homepage *http://erinternal.lanl.gov*.

4.1 *Development* — Procedures performed to (1) repair damage to the formation caused by drilling activities and (2) increase the porosity permeability of the materials surrounding the well screen. Development procedures serve to remove foreign materials from the groundwater, well annulus, or well screen during and/or after well installation, and to facilitate hydraulic communication between the formation and the well screen.

4.2 *Filter pack* — Sand or gravel that is emplaced in the well annulus surrounding a screen to prevent formational material from entering the well.

4.3 *Intermediate monitor well* — A monitor well that is screened across a perched-water zone other than that occuring in the shallow alluvium.

4.4 *Multiple completion* — A single well completed with more than one screen. Each well screen accesses a descrete perched-water zone or interval within the regional water table.

4.5 *pH* — The hydrogen ion concentration in water. A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with alkalinity and decreasing with acidity.

4.6 *Regional water table monitor well* — A monitor well that is screened below the water table in the regional aquifer.

4.7 *Site-Specific Health and Safety Plan (SSHASP)*—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

4.8 *Specific (electrical) conductance* — A measure of the ease with which a conduction current flows through a substance under the influence of an applied electric field. It is dependant upon the presence of ions (total and relative concentrations, valence, and mobility) and temperature. It is the reciprocal of resistivity and is measured in either siemens(S) or micro-ohms per centimeter (μohm/cm) at 25°C.

4.9 *Turbidity* — Refers to inorganic solids and organic matter suspended in water. Turbity, in nephelometric turbidity units (NTU), is measured as the intensity of light scattered by the suspended particulates in a water sample relative to a standard reference suspension. The goal of well development is to improve water quality until turbidity readings have stabilized at levels of less than 5 NTU.

4.10 *Well casing volume* — volume of water standing in a well. One casing volume, in gallons, is computed as the measured length of the water column (ft) times the cross-sectional area of the well casing (ft^2) times 7.48 gal/ft^3.

5.0 BACKGROUND AND PRECAUTIONS

This SOP shall be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

5.1 Regulatory guidance for well completion may be found in the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (EPA, 1986), and the EPA Handbook (EPA, 1991).

5.2 All well drilling and installation procedures create a skin, or filter cake, on the borehole wall. During well development, the fine particulate matter is removed from the well or saturated formation near the screen. A secondary function of development is to settle the annular fill to a stable position.

5.3 The following factors influence the success of well development:

- the drilling method employed in the well construction
- the design and completion of the well
- the type and gradation of geologic material surrounding the screen

Because of the small size of weathering products from the volcanic tuff, in some of the alluvial canyon aquifers in the region, it is virtually impossible to eliminate turbidity while developing the well.

5.4 Well Development Methods

There are various techniques that may be effective in developing wells depending on the hydrogeologic conditions encountered in the aquifer, drilling method used, and well design. Since hydrogeologic conditions may be complex and unpredictable, a single SOP can not be developed that will apply to all possible situations. Rather, the methods discussed briefly below are intended to be used as alternatives or as a series of steps to achieve acceptable well development results. Refer to the site-specific work plan for more information on the scope of work activities for determining the most appropriate method to be used for existing conditions.

5.4.1 *Wire-brush method* — Running a tight-fitting wire brush up and down the interior of the well casing, screen, and sump serves to remove sediment and debris particles and clears the screen openings. Use of the wire-brush method followed by bailing is an effective primary development scheme preliminary to surging or pumping.

5.4.2 *Bailing method* — Bailing involves inserting and withdrawing of a bailer or length of pipe with an end cap on the bottom. Bailing serves to remove turbid water and exerts a surging action as the bailer passes the screen. After wire brushing of the well interior has been peformed, the well is bailed to remove sediment and debris. The bailing method is also used as an alternative when the formation or water-producing zone fails to supply water at sufficient rates to sustain development by pumping.

5.4.3 *Mechanical surging* — Surging involves raising and lowering a surge block inside the well to force water to flow into and out of a screen and through the filter pack. The seals on the surge block are the same diameter as the inside of the well casing or ½ in. smaller if surging is conducted inside the screened interval. Turbid water must frequently be bailed from the well so that fines are not forced into the formating and to prevent sand from locking up the surge block.

5.4.4 *Swabbing method* — A swab is a mechanical surging device that is pulled upward through the water column in a well. Swabbing may be done with single- or double-swab flanges and with or without water-bypass vents. Water may be injected into the well to the formation

through the swabbing tool. In this method, water flows into one part of the screen, through the filter pack and adjacent formation, and out in another part of the screen. Swabbing is an aggressive development method that may be suitable if the introduction of water is acceptable. Swabbing is not recommended for wells with plastic casing or screens.

5.4.5 *High-velocity jetting* — Jetting, or forcing water through the screen from nozzles on a pipe assembly, can clear screen openings. The jetting method is not always adviseable as it forces the fines back into the filter pack and formation, and adds large volumes of water to the system.

5.4.6 *Overpumping* — A simple method of removing fines from a water-bearing formation is by overpumping. This method involves alternately pumping the well at a rate that will force it to become dry and allowing it to recover. The overpumping method is not always effective, particularly in unconsolidated formations, and may result in a formation that is partially developed.

5.4.7 *Pump development* — Pump development is commonly used as the final phase of well development for ER Project monitor wells after wire brushing and bailing methods have been performed. A submersible pump and packer assembly, if applicable, is installed and pumping at a sustainable rate is conducted until the water attains acceptable criteria to complete well development.

6.0 RESPONSIBLE PERSONNEL

The following personnel are responsible for activities identified in this procedure:

6.1 Focus Area Leader

6.2 Team Leader

6.3 Quality Program Project Leader

6.4 Author

6.5 ER Project personnel

7.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this SOP is provided in Attachment A. Additional equipment are listed in Attachment A of ER-SOP 4.01 and Attachment B of ER-SOP 5.01.

8.0 PROCEDURE

Note: Subcontractors performing work under the ER Project's quality program may follow this standard operating procedure (SOP) for well development. Subcontractors may substitute their own procedure(s) provided the substitute meets the requirements prescribed by the ER Project Quality Management Plan, and have been approved by the ER Project's Quality Program Project Leader (QPPL) before starting designated activities.

Note: ER Project personnel may produce paper copies of this procedure printed from the controlled-document electronic file located at website http://erinternal.lanl.gov/home_links/Library_proc.htm. However, it is their responsibility to ensure that they are properly trained and are utilizing the current version of this procedure. The author may be contacted if text is unclear.

Note: Deviations from SOPs are made in accordance with QP-4.2, Standard Operating Procedure Development and documented in accordance with QP-5.7, Notebook Documentation for Environmental Restoration Techncial Activities.

8.1 Preoperation Activities

8.1.1 Coordinate efforts for on-site staging of water that is produced during development. Assemble containers for temporary water storage. The containers must be structurally sound, decontaminated, compatible with anticipated contaminants, and field manageable. All development water must be containerized until water can be discharged in accordance with an NMED approved Notice of Intent (NOI) or other appropriate disposal method. Clearly label each container with the location ID, date, and time. Labels should be placed on the side of the containers and covered with clear tape to ensure their permanence.

8.1.2 Decontaminate all equipment that will enter the well or come into contact with the development water before developing each well according to ER-SOP-1.08.

8.1.3 Assemble equipment on a plastic sheet in an area that is beyond the range of splashing development water activities.

8.1.4 Well development may begin as soon as is practical after the well is installed, but no sooner than 48 hrs after grouting is completed. Do not use any dispersing agents, acids, or disinfectants to enhance the development of the well unless specifically instructed in writing by the Focus Area Leader. If problems or unusual conditions arise that

require the addition of water to aide development, the site geologist should coordinate with the Focus Area Leader as soon as possible.

Note: In the installation of some monitoring wells in perched alluvial aquifers at Los Alamos, partial development is desirable before emplacing the bentonite seal and cement grout because of settling that commonly occurs.

8.2 Well Development Activities

8.2.1 Open the surface protective casing and remove the well cap (if applicable). Monitor air quality at the top of the casing and in the breathing zone using a PID or other suitable monitoring instrument.

8.2.2 Measure and record depth to water and the total depth of the well according to ER-SOP-7.02.

8.2.3 Perform wire-brush procedures throughout the interior length of the well casing, screen(s), and sump.

8.2.4 Begin bailing to remove turbid water from the well and sediment from the sump. Measure and record initial field chemical parameters (pH, electrical conductivity, and temperature) and turbidity. Periodically measure field paramters as specified in the site-specific Field Implementation Plan (FIP). Note and record volumes of water produced as bailing procedes. Continue bailing as prescribed by the FIP or as otherwise directed by the Focus Area Leader.

8.2.5 Begin pump-development procedures. For wells with multiple completions, each water-bearing zone is isolated using inflatable packers above and below the screen. The following general steps are taken to develop each screen individually and in succession:

8.2.5.1 The drilling contractor installs a submersible pump-and-packer assembly across the first screen to to be developed. Pumping is initiated at a sustainable rate that will not induce excessive drawdown.

8.2.5.2 A transducer and/or a bubble piezometer may be installed in the well to measure water levels during the pump-development phase.

8.2.5.3 When the pump has been turned on, collect a sample of the development water to measure and record initial field chemical parameters and turbidity. Note the initial color, clarity, and any obvious odor of the water. Periodically monitor water quality parameters throughout the pump-development phase as prescribed in the FIP. Likewise, note and record flow measurements (flow rate and volume

produced) as indicated by an in-line flow meter. Continue to record measurements until the screen interval has been fully developed.

8.2.6 In general, well development procedures will continue for each screen interval until (1) the development water becomes free of suspended sediment, (2) an appropriate volume of water has been purged, and (3) field parameters have stabilized. Criteria for completing well development are described as follows:

8.2.6.1 Turbidity citeria — The Hazardous and Solid Waste Amendments Permit (May, 1990) requires that well development shall continue until the turbidity readings stabilize at levels of less than NTU or cannot be improved. Be sure to document all turbidity measurements in the Daily Activity Log (Attachment A in ER-SOP-1.04). If the well is not free of sediment after the required volume of water has been removed, continue pumping until twice that volume has been purged or approval to cease development activities is authorized by the Focus Area Leader.

8.2.6.2 Purge volume criteria — For wells where borehole drilling was conducted without the use of drilling fluid (water, mud, or additives), purge a minimum of five casing volumes of water before stopping well development. In situations where the groundwater flow from the screen interval is exceeded by the development pumping rate, the well may temporarily dry up. Contact the Focus Area Leader when it is determined that five casing volumes can not be purged within a 24-hour period.

8.2.6.3 Field parameter criteria — This criterion for well development has been met when field chemical parameters have stabilized over a series of monitoring measurements.

8.2.6.4 Development criteria deviations — If it is determined that one or more of the above criteria for well development can not be met regardless of the amount of pumping, the site geologist will coordinate with the Focus Area Leader to select an alternate procedure for verifying that the well is adequately developed.

8.3 Documentation

8.3.1 All manually measured data and procedural descriptions should be recorded in a field notebook as required by QP-5.7.

8.3.2 Complete the appropriate data entry requirements on the Borehole/Well Completion Information form to document well development. A copy of the form and instructions for completing it are given in Attachment B of ER-SOP-5.01.

8.3.3 All deviations from the FIP should be documented in accordance with QP-4.2.

8.4 Postoperation Activities

8.4.1 Groundwater samples may be collected from the well in accordance with ER-SOP-1.03 as early as 30 days after well development is complete or as otherwise specified in project documents.

8.4.2 Insure that all equipment is accounted for and decontaminated (refer to ER-SOP-1.08).

8.5 Lessons Learned

During the performance of work, ER Project personnel shall identify, document and submit lessons learned in accordance with QP-3.2, Lessons Learned. This QP can be located at website: http://erinternal.lanl.gov/home_links/Library_proc.htm.

9.0 REFERENCES

ER Project personnel may locate the ER Project Quality Management Plan/ER Project QP requirements crosswalk at website http://erinternal.lanl.gov/home_links/Library_proc.htm.

The following documents are cited within this procedure:

QP-2.2, Personnel Orientation and Training

QP-3.2, Lessons Learned

QP-4.2, Standard Operating Procedure Development

QP-4.3, Records Management

QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

ER-SOP-1.03, Handling, Packaging, and Shipping of Samples

ER-SOP-1.04, Sample Control and Field Documentation

ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment

ER-SOP-4.01, Drilling Methods and Drill Site Management

ER-SOP-5.01, Monitoring Well and RFI Borehole Construction

ER-SOP-7.02, Fluid Level Measurements

EPA, “RCRA Ground Water Monitoring Technical Enforcement Guidance Document,” (OSWER, Washington D.C., 1986) (EPA-530SW86055).

EPA, “Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,” (Environmental Monitoring Systems Laboratory, Office of Research and Development, 1991).

10.0 RECORDS

The FTL is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

10.1 Completed Borehole/Well Construction Field Data Log (Attachment B in ER-SOP 5.01)

10.2 Completed Daily Drilling Summary Log (Attachment C in ER-SOP 4.01), which will include calibration data, deviations, and any additional comments.

10.3 Completed Summary of Well Development Procedures (Attachment B)

11.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Well Development Equipment and Supplies Checklist (1 page)

Attachment B: Summary of Well Development Procedures

Well Development Equipment and Supplies Checklist

____ Water level meter
____ Specific Conductance/Temperature/pH meter
____ Distilled water
____ Stopwatch
____ Plastic sheet
____ wire brush assembly
____ Bailer
____ Pump
____ Surge block
_____ Equipment and supplies listed in Attachment A of ER-SOP-4.01
_____ Borehole/Well Completion Information form (Attachment A in ER-SOP-5.01)
____ Any PPE listed or required in the SSHASP
____ Any additional supplies listed in associated procedures, as needed
_____ Turbidity meter with range of 0 – 400 NTU
_____ Photo-ionization detector (PID)
_____
_____

Other method-specific equipment (add below)

_____
_____
_____
_____
_____
_____
_____

Summary of Well Development Procedures/Plan

Well I.D. _____ Date development began _____ Date development ended _____

Screen No._____ Screen Interval (Perforations) _____ to _____

Formation:

Development Method	Final Development Criteria

Screen No._____ Screen Interval (Perforations) _____ to _____

Formation:

Development Method	Final Development Criteria

Screen No._____ Screen Interval (Perforations) _____ to _____

Formation:

Development Method	Final Development Criteria
This form is available online via a link from the form title in Section 11.	

Screen No._____ Screen Interval (Perforations) _____ to _____

Formation:

Development Method	Final Development Criteria

Example Only